

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Conveying and placing concrete.
- B. Placement under water.
- C. Consolidation.
- D. Construction joints.
- E. Expansion and contraction joints.
- F. Curing and protection.

1.02 RELATED SECTIONS

- A. Portland cement concrete specified in Section 03 05 15 - Portland Cement Concrete.
- B. Finishing and curing of formed and unformed concrete surfaces, including repair and patching of surface defects, are specified in Section 03 35 00 - Concrete Finishing.
- C. Shotcrete is specified in Section 03 37 13 - Shotcrete.
- D. Vapor barrier under slabs on grade is specified in Section 07 26 00 - Vapor Retarders.

1.03 MEASUREMENT AND PAYMENT

- A. General: Measurement and payment for cast-in-place concrete will be either by the lump-sum method or by the unit-price method as determined by the listing of the bid item for cast-in-place concrete indicated in the Bid Schedule of the Bid Form.
- B. Lump Sum: If the Bid Schedule indicates a lump-sum for cast-in-place concrete, the lump-sum method of measurement and payment will be in accordance with Section 01 20 00 - Price and Payment Procedures, Article 1.03.
- C. Unit Prices: If the Bid Schedule indicates a unit price for cast-in-place concrete, the unit-price method of measurement and payment will be as follows:

1. Measurement:

- a. Except as specified otherwise in other Sections of these Specifications or the Contract Specifications, each class of concrete and type of placement of cast-in-place concrete will be measured for payment by the cubic yard, and quantities will be computed, based on the neat lines or pay lines, section profiles, and dimensions indicated on the Contract Drawings, without deduction for chamfers, reinforcing steel and embedded items, and openings and recesses having an area of less than

two square feet.

- b. Additional concrete used to replace overcut or for overbreak, or to repair or replace defective work, will not be measured separately for payment.
- 2. Payment: Cast-in-place concrete will be paid for at the indicated Contract unit prices for the computed quantities as determined by the measurement method specified in Article 1.03.C.1.

1.04 DEFINITIONS

- A. The words and terms used in these Specifications conform with the definitions given in ACI 116R.

1.05 REFERENCES

- A. American Concrete Institute (ACI):

- 1. ACI 116R Cement and Concrete Terminology
- 2. ACI 117 Standard Specification for Tolerances for Concrete Construction and Materials
- 3. ACI 301 Standard Specifications for Structural Concrete
- 4. ACI 302.1R Guide for Concrete Floor and Slab Construction
- 5. ACI 303.1 Standard Specification for Cast-In-Place Architectural Concrete
- 6. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete
- 7. ACI 304.2R Placing Concrete by Pumping Methods
- 8. ACI 305R Hot Weather Concreting
- 9. ACI 306.1 Standard Specification for Cold Weather Concreting
- 10. ACI 308 Standard Practice for Curing Concrete
- 11. ACI 309R Guide for Consolidation of Concrete
- 12. ACI 318 Building Code Requirements for Structural Concrete
- 13. ACI 503.2 Standard Specification for Bonding Plastic Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive

- B. American Society for Testing and Materials (ASTM):

- 1. ASTM C31 Standard Practice of Making and Curing Concrete Test Specimens in the Field

2. ASTM C94 Specification for Ready-Mixed Concrete
3. ASTM C881 Specification for Epoxy-Resin-Base Bonding Systems for Concrete

1.06 SUBMITTALS

- A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.
- B. Shop Drawings:
 1. Submit drawings that indicate the locations of all joints in concrete, including construction joints, expansion joints, isolation joints, and contraction joints. Coordinate with the requirements specified in Section 03 11 00 - Concrete Forming.
 2. Submit drawings that indicate concrete placement schedule, method, sequence, location, and boundaries. Include each type and class of concrete, and quantity in cubic yards.
- C. Product Data: Submit manufacturer's product data for epoxy adhesive.
- D. Records and Reports: Report the location in the finished work of each mix design, and the start and completion times of placement of each batch of concrete placed for each date concrete is placed.

1.07 QUALITY ASSURANCE

- A. Tolerances:
 1. Concrete Tolerances: Comply with the requirements of ACI 117 as applicable. Coordinate with the requirements specified in Section 03 11 00 - Concrete Forming.
 2. Tolerances for Slabs and Flatwork: Comply with the requirements specified in Section 03 35 00 - Concrete Finishing.
- B. Architectural Concrete: Where concrete is indicated as architectural concrete exposed to public view, such concrete shall be produced in accordance with applicable requirements of ACI 301 and ACI 303.1.
- C. Site Mock-Ups:
 1. Refer to Section 01 43 38 - Field Samples and Mockups, for mock-up requirements and procedures.
 2. Construct site mock-ups for all architectural concrete work and formed concrete that will be exposed to the public in the finished work, not less than 4 feet by 6 feet in surface area, for review and acceptance by the Engineer, before starting the placement of concrete.

3. Approved site mock-ups shall set the standard for the various architectural concrete features, formed finishes, and colors of the concrete. Provide as many mock-ups as required to show all the different features and formed surfaces of the concrete.
- D. Cold Joints: Cold joints in concrete will not be permitted unless planned and treated properly as construction joints.
- E. Monitoring of Formwork: Provide monitoring of forms and embedded items to detect movement, or forms and embedded items out-of-alignment, from pressure of concrete placement.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Delivering and placing of concrete in hot weather and cold weather shall conform with applicable requirements of ACI 305R and ACI 306.1 and Section 03 05 15 - Portland Cement Concrete.
- B. Do not place concrete when the rate of evaporation of surface moisture from concrete exceeds 0.2 pounds per square foot per hour as indicated in Figure 2.1.5 of ACI 305R.
- C. Do not place concrete in, or adjacent to, any structure where piles are required until all piles in the structure have been driven or installed.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Formwork: Refer to Section 03 11 00 - Concrete Forming, for requirements.
- B. Joint Fillers and Sealers: Refer to Section 03 15 00 - Concrete Accessories, for requirements.
- C. Waterstops: Refer to Section 03 15 13 - Waterstops, for requirements.
- D. Reinforcing Steel: Refer to Section 03 20 00 - Concrete Reinforcing, for requirements.
- E. Portland Cement Concrete: Refer to Section 03 05 15 - Portland Cement Concrete, for mix designs and other requirements.
- F. Concrete Curing Materials: Refer to Section 03 35 00 - Concrete Finishing, for requirements.
- G. Vapor Barrier Materials: Refer to Section 07 26 00 - Vapor Retarders, for requirements.
- H. Epoxy Adhesive: ASTM C881, Type II for non-load-bearing concrete and Type V for load-bearing concrete, Grade and Class as determined by project conditions and requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Inspect forms, earth bearing surfaces, reinforcement, and embedded items, and obtain the

Engineer's written approval before placing concrete. Complete and sign a pour card on the form supplied by the Engineer. The Engineer shall countersign the card prior to commencing the pour.

3.02 PREPARATION

- A. Place concrete under the observation of the Engineer and with the Contractor's Quality Control Representative present to document requirements and results of the placement.
- B. Whenever possible, place concrete during normal working hours. When concrete- placement schedules require concrete placement at times other than normal working hours, ensure that the Engineer is notified and is present at the time of placement.
- C. Do not place concrete until conditions and facilities for the storage, handling, and transportation of concrete test specimens are in compliance with the requirements of ASTM C31 and Section 03 05 15 - Portland Cement Concrete, and are approved by the Engineer.
- D. Prior to placement of concrete, the subgrade shall be in a firm, well-drained condition, and of adequate and uniform load-bearing nature to support construction personnel, construction materials, construction equipment, and steel reinforcing mats without tracking, rutting, heaving, or settlement. All weak, soft, saturated, or otherwise unsuitable material shall be removed and replaced with structural backfill or lean concrete.
- E. All structure foundations, including those for Stations and for subway box, shall be inspected and approved, in writing, by a qualified, independent geotechnical engineer prior to placement of footings and base slabs, to confirm the adequacy of the supporting soil for concrete placement.
- F. Earth bottoms or bearing surfaces for footings and slabs shall be dampened but not saturated or muddied just before placing concrete.

3.03 TRANSPORTING

- A. Concrete shall be central-mixed concrete from a central batch plant, transported to the jobsite in a truck mixer, in accordance with the requirements specified in Section 03 05 15 - Portland Cement Concrete, and ASTM C94.
- B. Transport concrete to the jobsite in a manner that will assure efficient delivery of concrete to the point of placement without adversely altering specified properties with regard to water-cement ratio, slump, air entrainment, and homogeneity.

3.04 CONVEYING AND PLACING

- A. Placement Standards: Conveying and placing of concrete shall conform with applicable requirements of ACI 301, ACI 302.1R, ACI 304R, and ACI 318.

B. Handling and Depositing:

1. Concrete placing equipment shall have sufficient capacity to provide a placement rate that will preclude cold joints and that shall deposit the concrete without segregation or loss of ingredients.
2. Concrete placement, once started, shall be carried on as a continuous operation until the section of approved size and shape is completed.
3. Concrete shall be handled as rapidly as practicable from the mixer to the place of final deposit by methods that prevent the separation or loss of ingredients. Concrete shall be deposited, as nearly as practicable, in its final horizontal position to avoid redistribution or flowing.
4. Concrete shall not be dropped freely where reinforcing will cause segregation, nor shall it be dropped freely more than 5 feet. Concrete shall be deposited to maintain a plastic surface approximately horizontal.
5. In placing walls, columns, or thin sections (6 inches or less in thickness) of heights greater than 10 feet, concrete placement rate, lift thickness, and time intervals between lifts shall be as indicated on approved Shop Drawings. Openings in the form, elephant trunk tremies, or other approved devices, shall be used that will permit the concrete to be placed without segregation or accumulation of hardened concrete on the forms or metal reinforcement above the level of the fresh concrete.
6. Concrete that has partially hardened shall not be deposited in the work. The discharge of concrete shall be started not later than 60 minutes after the introduction of mixing water. Placing of concrete shall be completed within 90 minutes after the first introduction of water into the mix.

C. Pumping:

1. Concrete may be placed by pumping if the maximum slump can be maintained and if accepted in writing by the Engineer for the location proposed.
2. Placing concrete by pumping methods shall conform with applicable requirements of ACI 304R and ACI 304.2R.
3. Equipment for pumping shall be of such size and design as to ensure a continuous flow of concrete at the delivery end without separation of materials. Concrete from end of hose shall have a free fall of less than 5 feet. Pump hoses shall be supported on horses or similar devices so that reinforcement or post-tensioning ducts or tendons are not moved from their original position.
4. The concrete mix shall be designed to the same requirements as specified in Section 03 05 15 - Portland Cement Concrete, and may be altered for placement purposes with the prior approval of the Engineer.

3.05 PLACEMENT UNDER WATER

- A. Placement Standards: Placing of concrete in or under water shall conform with requirements of ACI 304R. All concrete to be placed under water shall be placed by the tremie method or by direct pumping.
- B. Placement Requirements: Deposit concrete in water only when indicated or approved in writing by the Engineer, and only under the observation of the Engineer. Use only tremie method and direct pumping with equipment that has been accepted by the Engineer.

3.06 CONSOLIDATION

- A. Concrete shall be thoroughly consolidated and compacted by mechanical vibration during placement in accordance with the requirements of ACI 309R.
- B. The Engineer will inspect concrete placement to confirm that proper placing methods are being employed, and that special techniques are being used in congested areas and around obstructions such as pipes and other embedded items. Check installation of embedded items for correct location and orientation during concrete placement.
- C. Conduct vibration in a systematic manner by competent, skilled, and experienced workers, with regularly maintained vibrators, and with sufficient back-up units at the jobsite. Use the largest and most powerful vibrator that can be effectively operated in the given work, with a minimum frequency of 8,000 vibrations or impulses per minute, and of sufficient amplitude to effectively consolidate the concrete.
- D. Insert and withdraw the vibrator vertically at uniform spacing over the entire area of the placement. Space the distance between insertions such that "spheres of influence" of each insertion overlap.
- E. Conduct vibration so as to produce concrete that is of uniform texture and appearance, free of honeycombing, air and rock pockets, streaking, cold joints, and visible lift lines.
- F. On vertical surfaces and on all architectural concrete where an as-cast finish is required, use additional vibration and spading as required to bring a full surface of mortar against the forms, so as to eliminate objectionable air voids, bug holes, and other surface defects. Additional procedures for vibrating concrete shall consist of the following:
 - 1. Reduce the distance between internal vibration insertions and increase the time for each insertion.
 - 2. Insert the vibrator as close to the face of the form as possible, without contacting the form.
 - 3. Use spading as a supplement to vibration at forms to provide fully filled out form surfaces without air holes and rock pockets.
 - 4. Provide vibration of forms only if approved by the Engineer for the location.

3.07 CONSTRUCTION JOINTS

- A. Construction joints will be permitted only where indicated or approved by the Engineer.
- B. Provide and prepare construction joints and install waterstops in accordance with the applicable requirements of ACI 301 and ACI 304R, and as specified in Section 03 11 00 - Concrete Forming.
- C. Make construction joints straight and as inconspicuous as possible, and in exact vertical and horizontal alignment with the structure, as the case may be.
- D. Use approved key, at least 1-1/2 inches in depth, at joints unless otherwise indicated or approved by the Engineer.
- E. Thoroughly clean the surface of the concrete at construction joints and remove laitance, loose or defective concrete, coatings, sand, sealing compound and other foreign material. Prepare surfaces of joints by sandblasting or other approved methods to remove laitance and expose aggregate uniformly.
- F. Immediately before new concrete is placed, wet the joint surfaces and remove standing water. To allow for shrinkage, do not place new concrete against the hardened concrete side of a construction joint for a minimum of 72 hours.
- G. Locate joints that are not indicated so that the strength of the structure is not impaired. Joint types and their locations are subject to prior approval of the Engineer.
- H. Ensure that reinforcement is continuous across construction joints.
- I. Place waterstops in construction joints where indicated.
- J. Where bonding of the joint is required, provide epoxy adhesive hereinbefore specified and apply in accordance with ACI 503.2.
- K. Retighten forms and dampen concrete surfaces before concrete placing is continued.
- L. Allow at least 72 hours to elapse before continuing concrete placement at a construction joint. Approval for accelerating the minimum time elapsing between adjacent placements will be based on tests and methods that confirm that a minimum moisture loss at a relatively constant temperature will be maintained for the period as necessary to control the heat of hydration and hardening of concrete, and to prevent shrinkage and thermal cracking.

3.08 EXPANSION AND CONTRACTION JOINTS

- A. Refer to Section 03 11 00 - Concrete Forming, for slab screeds and for formwork where expansion and contraction joints are indicated as architectural features, such as reveals or rustications.
- B. Refer to Section 03 15 00 - Concrete Accessories, for expansion joint filler material and joint sealing compound.

- C. Refer to Section 03 35 00 - Concrete Finishing, for finishing of edges of expansion joints in slabs with curved edging tool.

3.09 CURING AND PROTECTION

- A. Curing of concrete shall conform with applicable requirements of ACI 301 and ACI 308, except that the curing duration shall be a minimum period of ten days. HVFAC shall be cured a minimum of 28 days including an initial 10 days of moist curing. Curing with earth, sand, sawdust, straw, and hay will not be permitted.
- B. Keep concrete in a moist condition from the time it is placed until it has cured for at least ten days. Keep forms damp and cool until removal of forms.
- C. Immediately upon removal of forms, exposed concrete surfaces shall be kept moist by applying an approved curing compound or by covering with damp curing materials as specified in Section 03 35 00 - Concrete Finishing.
- D. Concrete shall not be permitted to dry during the curing period because of finishing operations.
- E. Protect fresh concrete from hot sun, drying winds, rain, damage, or soiling. Fog spray freshly placed slabs after bleed water dissipates and after finishing operations commence. Allow no slabs to become dry at any time until finishing operations are complete.
- F. Finishing and curing of slabs are specified in Section 03 35 00 - Concrete Finishing.
- G. Protect concrete from injurious action of the elements and defacement of any kind. Protect exposed concrete corners from traffic or use that will damage them in any way.
- H. Protect concrete during the curing period from mechanical and physical stresses that may be caused by heavy equipment movement, subjecting the concrete to load stress, load shock, or excessive vibration.

3.10 REPAIR OF SURFACE DEFECTS

- A. Refer to Section 03 35 00 - Concrete Finishing, for requirements.

END OF SECTION 03 30 00